# Demystifying action potentials: Making sense of neuroscience for all educational backgrounds

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## Introduction

Neuroscience is a challenging topic to teach, regardless of the student's educational level or prior experience in the biological and health sciences. The purpose of this project was to:

1) Facilitate neurophysiology instruction to first year medical students at the **Virginia Tech-Carilion School of Medicine** (VTCSOM; Roanoke, VA; https://medicine.vtc.vt.edu/).
2) Provide an opportunity for Virginia Tech medical students and graduate students to work together and gain experience teaching neuroscience through Science-Technology-Engineering-Math outreach.
3) Introduce basic principles of neuroscience to elementary school students in the Roanoke, VA community.

## VTCSOM Neuroscience Curriculum

- The first year of the VTCSOM M1 curriculum concludes with an eight-week block that focuses on the neurosciences.
- For the basic science domain, this curriculum combines sessions on basic neuroscience, gross neuroanatomy, and a Problem-Based Learning case the students work through throughout each week, culminating in the opportunity for the students to meet with the physician, patient, and patient's family or caretakers.
- Lecture sessions include hands-on activities, which are used to demonstrate basic neuroscience principles in our outreach program.
- At the end of their neuroscience block in the Spring of FY2020, students had the opportunity to demonstrate their knowledge of neuroscience by participating in an outreach event at Grandin Court Elementary School.

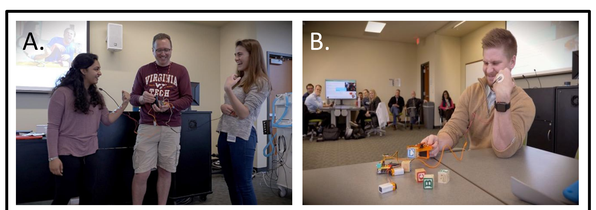


**FIGURE 1.** During a two-hour session in their basic science curriculum, M1 medical students used devices to demonstrate principles of neurophysiology. **(A)** To demonstrate neural pathways, a Human-to-Human Interface device was used, which permits one person to control the hand of another person. **(B)** To demonstrate cortical input and electrical activity of muscles, and to facilitate discussion on artificial limbs, a Robotic Claw device was used, which is controlled by the EMG signals from a student's muscles. Both devices were purchased from Backyard Brains (https://backyardbrains.com/).

## Community Outreach Opportunity

Prior to our outreach event at Grandin Court Elementary School, VTCSOM medical students and Virginia Tech graduate students met in advance to plan and run through the activities. Several days later, these students introduced basic neuroscience to 150 third, fourth, and fifth graders and their teachers at Grandin Court Elementary School (Roanoke, VA). We met with 50 students at a time, for one hour per group.

### Introductory Session

*First 10 minutes* – Interactive discussion of the functions of the brain (and why we need one).

**FIGURE 2.** Introduction. Answering questions from students about how their nervous systems work.

### Activity Rotation

*Next 40 minutes* – Kids were split into smaller groups and rotated through four interactive neuroscience demonstrations every 10 min:

A. Electricity of the Nervous System: We demonstrated the electrical activity hidden within our muscles using an EMG device. Kids volunteered to have their arm muscles tested. We explained the general concept of action potentials, and how they propagate up and down neural pathways to help their brain communicate with their muscles.

**FIGURE 3.** Activity A. Students use an EMG device to see their muscles in action.

B. Reflexes: We used reflex hammers and the patellar reflex to explain why we do not always need a brain. Kids volunteered to have their reflexes tested, and also tested the reflexes of the professional students.

**FIGURE 4.** Activity B. Students learn how to use a reflex hammer to test the patellar reflex.

C. Comparative Neuroanatomy: We had elementary students match images of mammals with images of brains. Anatomical models and real brains were also used to compare/contrast structure and function in humans, sheep, and mice.

**FIGURE 5.** Activity C. Students learn about the similarities and differences of mammalian brains.

D. Visual Plasticity: We explained how our visual system adapts to the world around us. We showed illusions and explained how our brain adjusts to fill in missing information. We also used vision distortion goggles to demonstrate how our brains can adapt to accommodate new perceptions of reality.

**FIGURE 6.** Activity D. To demonstrate visual plasticity, students try to toss squishy brains into buckets while wearing vision distortion goggles. Full description of the activity and directions for making the goggles: https://www.exploratorium.edu/snacks/distortion-goggles

### Concluding Session

*Last 10 minutes* - Wrap-up session with the entire group that focused on how we can keep our brains healthy. We had squishy brains from the Visual Plasticity activity for each of the kids to take home.

## Results

- The medical students who participated in the outreach event "felt personal satisfaction and enjoyment having had the experience", conveyed a "desire for future opportunities to teach in the community", and felt that they "understood neurophysiology better after having to teach it to the children".
- The elementary school children seemed to greatly enjoy the experience. The activities kept them engaged for the duration of the event, and they learned about several important topics related to their bodies.
- The elementary school teachers also enjoyed the experience, and have already invited us back for next year.
- Thanks to word-of-mouth, the success of this project has also opened up new opportunities with additional community partners and additional schools.

## Conclusion

Community outreach is a valuable tool that may improve medical student education.

**FIGURE 7.** Video synopsis of the outreach event. https://www.youtube.com/watch?v=M8oOdDhwic4

## Additional Information

- This project was supported by generous funding from the VTCSOM Department of Basic Science Education, and a 2019 Instructional Innovation Grant from the Virginia Tech Center for Excellence in Teaching and Learning (to KKR).
- For the publication of this study, written permission was acquired for showing faces of Virginia Tech graduate and medical students, and Grandin Court Elementary School students.